Marine Physical Laboratory

SWellEX Experiment Planning and Data Analysis

W. S. Hodgkiss

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Final Report

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University of California, San Diego
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Abstract

SWellEx-3 (Shallow Water evaluation cell Experiment #3), was carried out in July 1994 west of Point Loma in approximately 200 m water. A MPL 64-element vertical array was deployed from the R/P FLIP and the NRaD SWSS (Shallow Water Sensor String) horizontal line array was co-deployed 500 m to the east and cabled back to shore. During SWellEx-3, several source tow events were conducted which included radial tracks (both range-independent as well as cross-slope), arc (constant range but varying bathymetry) tracks, and CPA (closest point of approach) tracks. These events were designed to investigate the performance of matched field processing (MFP) in shallow water as well as to provide simultaneous data for intercomparison of vertical and horizontal line array processing. Vertical array, conventional (Bartlett), MFP has proven to be surprisingly robust to bathymetry mismatch. Horizontal array MFP near endfire was able to localize the source in range and depth even though the array aperture was relatively modest (300 m).

Research Objective

The objective of this project was to assist NRaD in both the planning and the execution of SWellEx-3 as well as to carry out initial matched field processing analysis of selected segments of the resulting data.

Research Summary

SWellEx-3 (Shallow Water evaluation cell Experiment #3), was carried out in July 1994 west of Point Loma in approximately 200 m water. A MPL 64-element vertical array was deployed from the R/P FLIP and the NRaD SWSS (Shallow Water Sensor String) horizontal line array was co-deployed 500 m to the east and cabled back to shore. During SWellEx-3, several source tow events were conducted which included radial tracks (both range-independent as well as cross-slope), arc (constant range but varying bathymetry) tracks, and CPA (closest point of approach) tracks. These events were designed to investigate the performance of matched field processing in shallow water as well as to provide simultaneous data for intercomparison of vertical and horizontal line array processing.

The primary thrust of this project was to assist NRaD in both the planning and the execution of SWellEx-3 as well as to carry out initial matched field processing analysis of selected segments of the resulting data. A portion of the effort was devoted to completing the characterization of ambient noise observed during SWellEx-1 (same location as SwellEx-3).

Both a vertical line array and a horizontal planar array were deployed in SWellEx-1. These two arrays provided an unique opportunity to observe simultaneously the time-evolving vertical and horizontal directionality of the shallow water ambient noise field. Several selected data segments were analyzed over a variety of time scales (e.g. 6 hours, 1.5 hours, and 0.25 hours). Dominant shipping sources were identified geographically and the observed vertical and horizontal directionality related to source-array propagation characteristics. A surprisingly large contribution to the ambient noise field at night was due to biologics (sounds made by fish of the croaker family). The results from this analysis are contained in [1-2].

The planning for SWellEx-3 built on the experience gained from SWellEx-1 and and SWellEx-2. In particular, the space-time sampling

strategy for water column sound speed structure and the design of the source tow events were influenced substantially as a result of lessons learned from these experiments. A modification to the deployment of the vertical line array from the R/P FLIP was designed and tested during an engineering sea test which was carried out in May 1994. The modification involved setting the bottom of the array on the seafloor with buoyancy on top to keep the array straight. A relatively slack tether containing the array umbilical cable (power/telemetry) then connected the top of the array to FLIP. This deployment strategy was successful and avoided the slight pendulum motion of FLIP and the array experienced in SWellEx-1.

Matched field processing (MFP) has been carried out on selected segments of both the vertical and horizontal line data collected during SWellEx-3. Vertical array, conventional (Bartlett), MFP has proven to be surprisingly robust to bathymetry mismatch. During the Arcmfp-1 event, the source was towed north along a range-independent track then east along an arc track where the water depth decreased from 200 m to 100 m. Replica vectors calculated for the northerly track were used for the entire event. Rather than breaking up due to the increasingly severe environmental mismatch, the broadband matched field output peak in range and depth behaved in a consistent way - both the predicted range and depth of the source became increasingly greater than its true range and depth as the actual water depth decreased. A simple analytical model was developed to predict this behavior. These results are documented in [3-5].

Horizontal array MFP was carried out using SWSS data from a CPA event. The source track went from westerly endfire (range ~3 km) to nearly northerly broadside (~2 km range). Within 45 degrees of endfire, horizontal array MFP was able to localize the source in range and depth even though the array aperture (Node 3) was relatively modest (300 m). These results are documented in [6].

References

[1] G. D'Spain, T. Richardson, W. Hodgkiss, and L. Berger, "Ambient Noise Vertical and Horizontal Directionality During SWellEx-1," J. Acoust. Soc. Am. 95(5): 2825 (1994).

[2] G. D'Spain, T. Richardson, W. Hodgkiss, and L. Berger, "Ambient Noise Vertical and Horizontal Directionality During SWellEx-1," MPL TM-443 (November 1994).

[3] G. D'Spain, J. Murray, W. Hodgkiss, and N. Booth, "Predicting the Broadband Matched Field Processing Results for the Arc Event During SWellEx-3," MPL TM-442 (October 1994).

[4] W. Hodgkiss, G. D'Spain, J. Murray, and N. Booth, "Broadband Matched Field Processing Range-Depth Ambiguities in a Range-Dependent Environment," Seventh Matched-Field Processing Workshop, Defence Research Establishment Pacific (DREP), 5-7 December 1994.

[5] G. D'Spain, J. Murray, W. Hodgkiss, and N. Booth, "Mirages in shallow water matched field processing," J. Acoust. Soc. Am. 97(5): 3291 (1995).

[6] W. Hodgkiss, J. Murray, K. Kim, and G. D'Spain, "Broadband matched-field source localization with a horizontal line array in shallow water," J. Acoust. Soc. Am. 97(5): 3291 (1995).

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